

REMARKS

Reexamination and reconsideration of this application as amended is requested. By this amendment, Claims 1, 12, and 18, have been amended. After this amendment, Claims 1-29 remain pending in this application. Applicant submits that the present response places the application in condition for allowance, or at least presents the application in better form for appeal. Entry of the present response is therefore respectfully requested.

Claim Rejections - 35 USC § 102

(1-16) The Examiner rejected Claims 1, 4-9, 12-18, and 21-26 under 35 U.S.C. 102(b) as being anticipated by Chen and Medioni, “A Volumetric Stereo Matching Method: Application to Image-Based Modeling” IEEE 19999.

Applicant has amended independent Claims 1, 12, and 18 to more clearly and distinctly recite the present invention. Applicant has amended Claims 1, 12 and 18 to more clearly recite “simultaneously matching correspondence to a plurality of pixels in three or more images”. Support for these amendments may be found in the specification as originally filed, see for example FIG. 3; page 14, lines 10-15; and page 15, lines 17-19. No new matter was added.

The Examiner directs Applicant to example 4 on page 34 in Chen [VSMM99], wherein Chen [VSMM99] teaches using two cameras to take multiple pictures of a tea pot spinning on a turntable. In fact, Chen [VSMM99] teaches that only two images are matched at a time. See Chen [VSMM99] generally and at section 3.2 “Disparity surface extraction”. Chen [VSMM99] may take multiple pictures (by using only two cameras), but Chen [VSMM99] does not simultaneously match three or more images.

Furthermore, in Section 3.2.1 of Chen [VSMM99] entitled “Algorithm description”, Chen [VSMM99] states “the output from our matching algorithm is a disparity map which

corresponds to the voxels that comprise the disparity surface. This is where it differentiates itself from volume rendering, or other matching methods that model the disparity surface as a continuous function". Chen [VSMM99] is comparing disparity surfaces, in other words, Chen [VSMM99] compares the disparity between two surfaces at a time. The (u,v,d) space is working with only two images at a time.

In contrast, claims 1, 12, and 18 of the present invention, recites "tracing pixels in a virtual piecewise continuous depth surface by spatial propagation starting from the detected pixels in the base image by using the matching and corresponding plurality of pixels in the three or more images to create the virtual piecewise continuous depth surface viewed from the base image, each successfully traced pixel being associated with a depth in the scene viewed from the base image". The present invention and Chen [VSMM99] are working in two different spaces. The present invention, as recited for claims 1, 12, 18, is working in a multiple image volume space and Chen [VSMM99] is working in a two-image disparity space. Chen [VSMM99] specifically states that it is not performing volume rendering. See previous paragraph. Disparity space cannot be used when working when matching three or more images simultaneously.

Therefore, Chen [VSMM99] does not teach, anticipate, or suggest:

[...]

determining 3-D depth of the plurality of pixels in the base image by simultaneously matching correspondence to a plurality of pixels in three or more images, each image representing one of the at least three views of the scene, wherein each of the at least three views of the scene are situated in a non-linear arrangement and are further oriented in a plurality of non-parallel planes relative to each other; and

tracing pixels in a virtual piecewise continuous depth surface by spatial propagation starting from the detected pixels in the base image by using the matching and corresponding plurality of pixels in the three or more images to create the virtual piecewise continuous depth surface viewed from the base image, each successfully traced pixel being associated with a depth in the scene viewed from the base image

as recited for Claim 1 and similarly for Claims 12 and 18.

The Examiner cites 35 U.S.C. § 102(b) and a proper rejection requires that a single reference teach (i.e., identically describe) each and every element of the rejected claims as being anticipated by Chen [VSMM99].¹ Because the elements in independent claims 1, 12, and 18 of “simultaneously matching correspondence to a plurality of pixels in three or more images” and “tracing pixels in a virtual piecewise continuous depth surface by spatial propagation starting from the detected pixels in the base image by using the matching and corresponding plurality of pixels in the three or more images to create the virtual piecewise continuous depth surface viewed from the base image, each successfully traced pixel being associated with a depth in the scene viewed from the base image” are not taught, anticipated, or even suggested, by Chen [VSMM99], the Chen [VSMM99] reference does not teach, anticipate, or suggest, each and every element of Claims 1, 12, and 18.

For the foregoing reasons, Claims 1, 12, and 18 distinguish over Chen [VSMM9]. Claims 4-9, 13-17, and 21-26 depend from claims 1, 12, and 18, respectively. Since dependent claims contain all the limitations of the independent claims, claims 4-9, 13-17, and 21-26 distinguish over Chen [VSMM9], as well. Accordingly, Applicant believes that the rejection under 35 U.S.C. § 102(b) has been overcome and respectfully requests that this rejection be withdrawn.

Claim Rejections - 35 USC § 103

(17-20) The Examiner rejected Claims 27-28 under 35 U.S.C. 103(a) as being unpatentable over Chen and Medioni, “A Volumetric Stereo Matching Method: Application to Image-Based

¹ See MPEP §2131 (Emphasis Added) “A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference.” *Verdegaal Bros. v. Union Oil Co. of California*, 814 F.2d 628, 631, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987). “The identical invention must be shown in as complete detail as is contained in the ... claim.”

Modeling” IEEE 1999.

Claims 27-28 depend from amended Claim 18. The above arguments and remarks regarding Claim 18 are likewise applicable here in support of the allowability of Claims 27-28. These applicable arguments have already been presented above and will not be repeated here.

Accordingly, in view of the amendments and remarks above, since Chen [VSMM99] does not teach, anticipate, or suggest, the presently claimed “...determining 3-D depth of the plurality of pixels in the base image by simultaneously matching correspondence to a plurality of pixels in three or more images, each image representing one of the at least three views of the scene, wherein each of the at least three views of the scene are situated in a non-linear arrangement and are further oriented in a plurality of non-parallel planes relative to each other; and tracing pixels in a virtual piecewise continuous depth surface by spatial propagation starting from the detected pixels in the base image by using the matching and corresponding plurality of pixels in the three or more images to create the virtual piecewise continuous depth surface viewed from the base image, each successfully traced pixel being associated with a depth in the scene viewed from the base image” as recited for amended Claim 18 from which Claims 26-27 depend from, Applicant believes that the rejection of Claims 27-28 under 35 U.S.C. 103(a) has been overcome. The Examiner should withdraw the rejection of these claims.

(21-29) The Examiner rejected Claims 2-3 and 19-20 under 35 U.S.C. 103(a) as being unpatentable over Chen and Medioni, “A Volumetric Stereo Matching Method: Application to Image-Based Modeling” IEEE 1999 in view of Zhang, Deriche, Faugeras, and Luong, “A Robust Technique for Matching Two Uncalibrated Images Through the Recovery of Unknown Epipolar Geometry”, INRIA 1994).

Claims 2-3 and 19-20 depend from amended Claims 1 and 18, respectively. The above arguments and remarks regarding Claims 1 and 18 are likewise applicable here in support of the allowability of Claims 2-3 and 19-20. These applicable arguments have already been presented above and will not be repeated here.

Zhang teaches a robust technique for matching two uncalibrated images through the recovery of the unknown epipolar geometry. The Examiner has directed Applicant to Section 6.3 on pages 16-19 of Zhang, wherein Zhang teaches a stereo matching method. Additionally, Zhang teaches that outliers will severely affect the precision of the fundamental Matrix taught by Zhang. Therefore, possible outliers should be taken into account in the initial correspondences. However, Zhang does not teach or suggest “determining 3-D depth of the plurality of pixels in the base image by simultaneously matching correspondence to a plurality of pixels in three or more images” nor does the reference teach or suggest that each image represents one of the at least three views of the scene that are situated in a non-linear arrangement and are further oriented in a plurality of non-parallel planes relative to each other. See for example FIG. 1. Further, Zhang does not teach or suggest “tracing pixels in a virtual piecewise continuous depth surface by spatial propagation starting from the detected pixels in the base image by using the matching and corresponding plurality of pixels in the three or more images to create the virtual piecewise continuous depth surface viewed from the base image, each successfully traced pixel being associated with a depth in the scene viewed from the base image” as presently claimed in Claims 1 and 18. Therefore, Zhang does not teach or suggest the presently claimed invention as recited for amended independent Claims 1 and 18 from which dependent Claims 2-3 and 19-20 depend from, respectively.

Accordingly, in view of the amendments and remarks above, since Chen [VSMM99] taken alone and/or in view of Zhang does not teach, anticipate, or suggest, the presently claimed “...determining 3-D depth of the plurality of pixels in the base image by simultaneously matching correspondence to a plurality of pixels in three or more images, each image representing one of the at least three views of the scene, wherein each of the at least three views of the scene are situated in a non-linear arrangement and are further oriented in a plurality of non-parallel planes relative to each other; and tracing pixels in a virtual piecewise continuous depth surface by spatial propagation starting from the detected pixels in the base image by using the matching and corresponding plurality of pixels in the three or more images to create the virtual piecewise continuous depth surface viewed from the base image, each successfully traced

pixel being associated with a depth in the scene viewed from the base image” as recited for amended Claims 1 and 18 from which Claims 2-3 and 19-20 respectively depend from, Applicant believes that the rejection of Claims 2-3 and 19-20 under 35 U.S.C. 103(a) has been overcome. The Examiner should withdraw the rejection of these claims.

(30-35) The Examiner rejected Claims 10-11 under 35 U.S.C. 103(a) as being unpatentable over Chen and Medioni, “A Volumetric Stereo Matching Method: Application to Image-Based Modeling” IEEE 1999 in view of Okutomi and Kanade, “A Multiple-Baseline Stereo”, IEEE 1993 in further view of Lewis, “Fast normalized Cross-Correlation”, 1995.

Claims 10-11 depend from amended Claim 1. The above arguments and remarks regarding Claim 1 are likewise applicable here in support of the allowability of Claims 10-11. These applicable arguments have already been presented above and will not be repeated here.

As has already been previously discussed in Applicant’s previous response to the previous Office Action (see OA dated October 10, 2004), Okutomi teaches a stereo matching method that uses multiple stereo pairs with various baselines to obtain precise distance estimates without suffering from ambiguity. The Examiner specifically pointed to Okutomi, the Abstract - sentence 1, and also page 353-355, and page 362, wherein Okutomi teaches that the summation of the sum of squared differences (SSD) from multiple stereo pairs can be used to indicate the “correctness” of a set of matching points. However, Okutomi clearly does not teach or suggest the presently claimed invention as recited for amended independent Claim 1, and for dependent Claims 10-11.

Lewis teaches how unnormalized cross correlation can be efficiently normalized using precomputing integrals of the image and image² over the search window. However, it should be clear that Lewis does not teach or suggest the presently claimed invention as recited for amended independent Claim 1, and for dependent Claims 10-11.

Accordingly, in view of the amendments and remarks above, since the teachings of Chen [VSMM99] taken alone and/or in view of the teachings of Okutomi and/or in view of the

teachings of Lewis do not teach, anticipate, or suggest, the presently claimed "...determining 3-D depth of the plurality of pixels in the base image by simultaneously matching correspondence to a plurality of pixels in three or more images, each image representing one of the at least three views of the scene, wherein each of the at least three views of the scene are situated in a non-linear arrangement and are further oriented in a plurality of non-parallel planes relative to each other; and tracing pixels in a virtual piecewise continuous depth surface by spatial propagation starting from the detected pixels in the base image by using the matching and corresponding plurality of pixels in the three or more images to create the virtual piecewise continuous depth surface viewed from the base image, each successfully traced pixel being associated with a depth in the scene viewed from the base image" as recited for amended Claims 1 from which Claims 10-11 respectively depend from, Applicant believes that the rejection of Claims 10-11 under 35 U.S.C. 103(a) has been overcome. The Examiner should withdraw the rejection of these claims.

Allowable/Allowed Subject Matter

(36-37) Applicant would like to thank the Examiner for indicating the allowability of claim 29.

Conclusion

The foregoing is submitted as full and complete response to the Official Action mailed June 14, 2005, and it is submitted that Claims 1-29 are in condition for allowance or are at least presented in better form for appeal. Reconsideration of the rejection is requested. Allowance of Claims 1-29 is earnestly solicited.

No amendment made was related to the statutory requirements of patentability unless expressly stated herein. No amendment made was for the purpose of narrowing the scope of any claim, unless Applicant has argued herein that such amendment was made to distinguish over a particular reference or combination of references.

Applicant acknowledges the continuing duty of candor and good faith to disclose information known to be material to the examination of this application. In accordance with 37 CFR § 1.56, all such information is dutifully made of record. The foreseeable equivalents of any territory surrendered by amendment are limited to the territory taught by the information of

record. No other territory afforded by the doctrine of equivalents is knowingly surrendered and everything else is unforeseeable at the time of this amendment by the Applicant and the attorneys.

The present application, after entry of this amendment, comprises twenty-nine (29) claims, including four (4) independent claims. Applicant has previously paid for twenty-nine (29) claims including four (4) independent claims. Applicant, therefore, believes that a fee for claims amendment is currently not due.

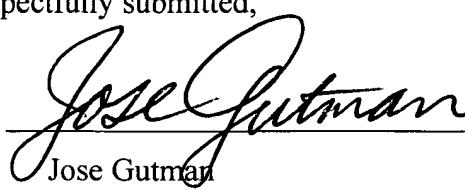
If the Examiner believes that there are any informalities that can be corrected by Examiner's amendment, or that in any way it would help expedite the prosecution of the patent application, a telephone call to the undersigned at (561) 989-9811 is respectfully solicited.

The Commissioner is hereby authorized to charge any fees that may be required or credit any overpayment to Deposit Account **50-1556**.

In view of the preceding discussion, it is submitted that the claims are in condition for allowance. Reconsideration and re-examination is requested.

Respectfully submitted,

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